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APPENDIX

Table A-1. NATIONAL RAINFALL-RUNOFF-QUALITY DATA BANK SUMMARY OF DATA - DECEMBER 1976[a]

Location	Catchment	Area, acre	Drainage system	Number of storms with Quantity	Number of storms with Quality
Broward County, Florida	Residential	47.5	S	32[b]	35[b]
	Commercial	39.0	S	--[a]	14[b]
	Transportation	28.4	S	--[a]	4[b]
San Francisco, California	Baker Street	168	C	4	4
	Mariposa Street	223	C	4	4
	Brotherhood Way	180	C	4	4
	Vincente Street, N	16	S	1	1
	Vincente Street, S	21	S	1	1
	Selby Street	3400	C	8	8
	Laguna Street	375	C	2	2
Racine, Wisconsin	Site I	829	C	9	9
Lincoln, Nebraska	39 and Holdrege	79	S	20	20
	63 and Holdrege	85	S	15	15
	78 and A	357	S	14	14
Windsor, Ontario	Labadie Road	29.5	S	22	22
Lancaster, Pennsylvania	Stevens Avenue	134	C	7	7
Seattle, Washington	View Ridge 1	630	S	30	30
	View Ridge 2	105	S	5	5
	South Seattle	27.5	S	31	31
	Southcenter	24	S	30	30
	Lake Hills	150	S	7	7
	Highlands	85	S	4	4
	Central Business District	27.8	C	5	5
Baltimore, Maryland	Northwood	47.4	S	14	--
	Gray Haven	23.3	S	29	--
Chicago, Illinois	Oakdale	12.9	C	21	--
Champaign-Urbana, Illinois	Boneyard Creek	2290	S	28	--
Bucyrus, Ohio	Sewer District No. 8	179	C	10	--
Falls Church, Virginia	Tripps Run	332	S	10	--
Durham, North Carolina	Third Fork	1069	S	15	--
Winston-Salem, North Carolina	Tar Branch	384	S	17	--
Jackson, Mississippi	Crane Creek	285	S	17	--
Wichita, Kansas	Dry Creek	1883	S	8	--
Westbury, New York	Woodoak Drive	14.7	S	10	--
Philadelphia, Pennsylvania	Wingonocking	5326	C	16	--
Los Angeles, California	Echo Park	252	S	18	--

a See discussion in Section 1

b Additional data currently being reduced by USGS.

acres x 0.405 = ha

GLOSSARY

Aerated lagoon--A natural or artificial wastewater treatment lagoon (generally from 4 to 12 feet deep) in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

Biological treatment processes--Means of treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Trickling filters, activated sludge processes, and lagoons are examples.

BMP--Best Management Practices. Nonstructural and low structurally intensive measures for controlling stormwater pollution by attacking the problem at its source.

BOD--Biochemical Oxygen Demand. The quantity of dissolved oxygen used by microorganisms in the biochemical oxidation of organic matter and oxidizable inorganic matter by aerobic biological action. Generally refers to the standard 5-day BOD test.

Combined sewage--Sewage containing both domestic sewage and surface water or stormwater, with or without industrial wastes. Includes flow in heavily infiltrated sanitary sewer systems as well as combined sewer systems.

Combined sewer--A sewer receiving both intercepted surface runoff and municipal sewage.

Combined sewer overflow--Flow from a combined sewer in excess of the interceptor capacity that is discharged into a receiving water.

COD--Chemical Oxygen Demand. The quantity of oxygen required to oxidize organic matter in the presence of a strong oxidizing agent in an acidic medium.

CSO--Combined Sewer Overflow.

Detention--The slowing, dampening, or attenuating of flows either entering the sewer system or within the sewer system by temporarily holding the water on a surface area, in a storage basin, or within the sewer itself.

Disinfection--The art of killing the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

Domestic sewage--Sewage derived principally from dwellings, business buildings, institutions, and the like. It may or may not contain groundwater.

DPD--A method for measuring chlorine dioxide, hypochlorite, free chlorine, and cloramines using the DPD (N. N. Diethyl-p-phenylenediamine) indicator solution.

Dual treatment--Those processes or facilities designed for operating on both dry- and wet-weather flows.

Dynamic regulator--A semiautomatic or automatic regulator device which may or may not have movable parts that are sensitive to hydraulic conditions at their points of installation and are capable of adjusting themselves to variations in such conditions or of being adjusted by remote control to meet hydraulic conditions at points of installation or at other points in the total combined sewer system.

Equalization--The averaging (or method for averaging) of variations in flow and composition of a liquid.

First flush--The condition, often occurring in storm sewer discharges and combined sewer overflows, in which a disproportionately high pollutional load is carried in the first portion of the discharge or overflow.

F/M--Food to Microorganism Ratio. Calculated as the rate of BOD loading in kg (lbs) per day divided by the kg (lbs) of mixed liquor suspended solids under aeration in the contact tank only.

Infiltrated municipal sewage--That flow in a sanitary sewer resulting from a combination of municipal sewage and excessive volumes of infiltration/inflow resulting from precipitation.

Infiltration--The water entering a sewer system and service connections from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Infiltration ratio--The ratio of rainfall volume entering the sewers to the total rainfall volume.

Inflow--The water discharged into a sewer system and service connections from such sources as, but not limited to, roof leaders, cellar, yard, and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm sewers and combined sewers, catch basins, stormwaters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

In-system--Within the physical confines of the sewer pipe network.

Intercepted surface runoff--That portion of surface runoff that enters a sewer, either storm or combined, directly through catchbasins, inlets. etc.

Interceptor--A sewer that receives dry-weather flow from a number of transverse combined sewers and additional predetermined quantities of intercepted surface runoff and conveys such waters to a point for treatment.

Intermittent point source--Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged on a noncontinuous basis.

Municipal sewage--Sewage from a community which may be composed of domestic sewage, industrial wastes, or both.

Nonpoint source--Any unconfined and nondiscrete conveyance from which pollutants are or may be discharged.

Nonsewered urban runoff--That part of the precipitation which runs off the surface of an urban drainage area and reaches a stream or other body of water without passing through a sewer system.

Overflow--(1) The flow discharging from a sewer resulting from combined sewage, storm wastewater, or extraneous flows and normal flows that exceed the sewer capacity. (2) The location at which such flows leave the sewer.

Oxidation pond--A basin (generally 2 to 6 feet deep) used for retention of wastewaters before final disposal, in which biological oxidation of organic matter is effected by natural or artificially accelerated transfer of oxygen to the water from air.

Physical-chemical treatment processes--Means of treatment in which the removal of pollutants is brought about primarily by chemical clarification in conjunction with physical processes. The process string generally includes preliminary treatment, chemical clarification, filtration, carbon adsorption, and disinfection.

Physical treatment operations--Means of treatment in which the application of physical forces predominates. Screening, sedimentation, flotation, and filtration are examples. Physical treatment operations may or may not include chemical additions.

Point source--Any discernible, confined, and discrete conveyance from which pollutants are or may be discharged.

Pollutant--Any harmful or objectionable material in or change in physical characteristic of water or sewage.

Pretreatment--The removal of material such as gross solids, grit, grease, and scum from sewage flows prior to physical, biological, or physical-chemical treatment processes to improve treatability. Pretreatment may include screening, grit removal, skimming, preaeration, and flocculation.

Regulator--A structure which controls the amount of sewage entering an interceptor by storing in a trunk line or diverting some portion of the flow to an outfall.

Retention--The prevention of runoff from entering the sewer system by storing on a surface area or in a storage basin.

Sanitary sewer--A sewer that carries liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with relatively low quantities of ground, storm, and surface waters that are not admitted intentionally.

SCS--Soil Conservation Service.

Sewer--A pipe or conduit generally closed, but normally not flowing full, for carrying sewage or other waste liquids.

Sewerage--System of piping, with appurtenances, for collecting and conveying wastewaters from source to discharge.

SG--Specific Gravity.

Static regulator--A regulator device which has no moving parts or has movable parts which are insensitive to hydraulic conditions at the point of installation and which are not capable of adjusting themselves to meet varying flow or level conditions in the regulator-overflow structure.

Storm flow--Overland flow, sewer flow, or receiving stream flow caused totally or partially by surface runoff or snowmelt.

Storm sewer--A sewer that carries intercepted surface runoff, street wash and other wash waters, or drainage, but excludes domestic sewage and industrial wastes.

Storm sewer discharge--Flow from a storm sewer that is discharged into a receiving water.

Stormwater--Water resulting from precipitation which either percolates into the soil, runs off freely from the surface, or is captured by storm sewer, combined sewer, and to a limited degree sanitary sewer facilities.

Surcharge--The flow condition occurring in closed conduits when the hydraulic grade line is above the crown of the sewer.

Surface runoff--Precipitation that falls onto the surfaces of roots, streets, ground, etc., and is not absorbed or retained by that surface, thereby collecting and running off.

Trickling filter--A filter consisting of an artificial bed of coarse material, such as broken stone, clinkers, slate, slats, brush, or plastic materials, over which sewage is distributed or applied in drops, films, or spray from troughs, drippers, moving distributors, or fixed nozzles, and through which it trickles to the underdrains, giving opportunity for the formation of zoogleal slimes which clarify and oxidize the sewage.

Urban runoff--Surface runoff from an urban drainage area that reaches a stream or other body of water or a sewer.

Wastewater--The spent water of a community. See Municipal Sewage and Combined Sewage.

CONVERSION FACTORS
U.S. Customary to SI (Metric)

U.S. customary unit			SI	
Name	Abbreviation	Multiplier	Symbol	Name
acre	acre	0 405	ha	hectare
acre-foot	acre-ft	1,233 5	m^3	cubic metre
acre-inch	acre-in.	102.79	m^3	cubic metre
cubic foot	ft^3	28 32	L	litre
		0.0283	m^3	cubic metre
cubic feet per minute	ft^3/min	0.0283	m^3/min	cubic metres per minute
cubic feet per minute per 100 gallons	ft^3/min 100 gal	0 00747	$m^3/min \cdot 100$ L	cubic metres per minute per 100 litres
cubic feet per pound	ft^3/lb	62.4	L/kg	litres per kilogram
cubic feet per second	ft^3/s	28.32	L/s	litres per second
cubic feet per square foot per minute	ft^3/ft^2 min	0 305	$m^3/m^2 \cdot min$	cubic metres per square metre per minute
cubic inch	$in.^3$	16.39	cm^3	cubic centimetre
		0 0164	L	litre
cubic yard	yd^3	0.765	m^3	cubic metre
		764.6	L	litre
degrees Fahrenheit	°F	0 555 (°F-32)	°C	degrees Celsius
feet per minute	ft/min	0.00508	m/s	metres per second
feet per second	ft/s	0.305	m/s	metres per second
foot (feet)	ft	0 305	m	metre(s)
gallon(s)	gal	3.785	L	litre(s)
gallons per acre per day	gal/acre·d	9 353	L/ha·d	litres per hectare per day
gallons per capita per day	gal/capita d	3.785	L/capita d	litres per capita per day
gallons per day	gal/d	4.381×10^{-5}	L/s	litres per second
gallons per foot per minute	gal/ft min	0.207	L/m s	litres per metre per second
gallons per minute	gal/min	0 0631	L/s	litres per second
gallons per square foot	gal/ft^2	40 743	L/m^2	litres per square metre
gallons per square foot per day	gal/ft^2 d	1.698×10^{-3}	$m^3/m^2 \cdot h$	cubic metres per square metre per hour
		0 283	m^3/ha min	cubic metres per hectare per minute
gallons per square foot per minute	$gal/ft^2 \cdot min$	2.445	$m^3/m^2 \cdot h$	cubic metres per square metre per hour
		0.679	$L/m^2 \cdot s$	litres per square metre per second
horsepower	hp	0.746	kW	kilowatts
inch(es)	in	2 54	cm	centimetre
inches per hour	in./h	2.54	cm/h	centimetres per hour
mile	mi	1 609	km	kilometre
million gallons	Mgal	3 785	ML	megalitres (litres x 10^6)
		3785 0	m^3	cubic metres
million gallons per acre	Mgal/acre	8353	m^3/ha	cubic metres per hectare
million gallons per acre per day	Mgal/acre d	0 039	m^3/m^2 h	cubic metres per square metre per hour
million gallons per day	Mgal/d	43.808	L/s	litres per second
		0.0438	m^3/s	cubic metres per second
million gallons per square mile	$Mgal/mi^2$	1 461	ML/km^2	megalitres per square kilometre
		1461	m^3/km^2	cubic metres per square kilometre
parts per billion	ppb	1 609	km	kilometre
parts per million	ppm	1 0	mg/L	milligrams per litre
pound(s)	lb	0.454	kg	kilogram(s)
		453 6	g	gram(s)
pounds per acre per day	lb/acre·d	1 121	kg/ha d	kilograms per hectare per day
pounds per cubic foot	lb/ft^3	16 018	kg/m^3	kilograms per cubic metre
pounds per 1000 cubic feet	lb/1000 ft^3	16 018	g/m^3	grams per cubic metre
		0 016	kg/m^3	kilograms per cubic metre
pounds per mile	lb/mi	0.282	kg/km	kilograms per kilometre
pounds per million gallons	lb/Mgal	0 120	mg/L	milligrams per litre
pounds per square foot	lb/ft^2	4.882×10^{-4}	kg/cm^2	kilograms per square centimetre
		4 882	kg/m^2	kilograms per square metre
pounds per 1000 square feet per day	lb/1000 $ft^2 \cdot d$	4.882×10^{-3}	kg/m^2 d	kilograms per square metre per day
pounds per square inch	$lb/in.^2$	0.0703	kg/cm^2	kilograms per square centimetre
square foot	ft^2	0.0929	m^2	square metre
square inch	in^2	6 452	cm^2	square centimetre
square mile	mi^2	2.590	km^2	square kilometre
		259 0	ha	hectare
square yard	yd^2	0 836	m^2	square metre
standard cubic feet per minute	std ft^3/min	1 699	m^3/h	cubic metres per hour
ton (short)	ton (short)	0 907	Mg (or t)	megagram (metric tonne)
tons per acre	tons/acre	2240	kg/ha	kilograms per hectare
tons per square mile	$tons/mi^2$	3 503	kg/ha	kilograms per hectare
yard	yd	0.914	m	metre

TECHNICAL REPORT DATA *(Please read Instructions on the reverse before completing)*		
1 REPORT NO. EPA-600/8-77-014	2	3 RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE URBAN STORMWATER MANAGEMENT AND TECHNOLOGY: UPDATE AND USERS' GUIDE		5 REPORT DATE September 1977 (Issuing Date)
		6 PERFORMING ORGANIZATION CODE
7 AUTHOR(S) John A. Lager, William G. Smith, William G. Lynard, Robert M. Finn, and E. John Finnemore		8. PERFORMING ORGANIZATION REPORT NO
9. PERFORMING ORGANIZATION NAME AND ADDRESS Metcalf & Eddy, Inc. 1029 Corporation Way P.O. Box 10-046 Palo Alto, California 94303		10 PROGRAM ELEMENT NO. 1BC611
		11. CONTRACT NO 68-03-2228
12. SPONSORING AGENCY NAME AND ADDRESS Municipal Environmental Research Laboratory--Cin.,OH Office of Research and Development U.S. Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED Final Report
		14 SPONSORING AGENCY CODE EPA/600/14

15. SUPPLEMENTARY NOTES: Supplement to EPA-670/2-74-040, "Urban Stormwater Management and Technology, An Assessment." Project Officer: Richard Field, Chief, Storm and Combined Sewer Section, (201) 321-6674, 8-340-6674

16. ABSTRACT

A continuation and reexamination of the state-of-the-art of storm and combined sewer overflow technology is presented. Essential areas of progress of the stormwater research and development program are keyed to the approach methodology and user assistance tools available, stormwater characterization, and evaluation of control measures. Results of the program are visible through current and ongoing master planning efforts. Assessment of urban runoff pollution is referenced to the developing national data base, localized through selective monitoring and analysis, and quantified as to potential source and magnitude using techniques ranging from simplified desktop procedures to complex simulation models. Stormwater pollutants are characterized by (1) source potential, (2) discharge characteristics, (3) residual products, and (4) receiving water impacts. Control and corrective measures are separated into nonstructural, termed Best Management Practices (BMPs), and structural alternatives. Best Management Practices focus on source abatement, whereas structural alternates roughly parallel conventional wastewater treatment practices of end-of-the-pipe correction. Structural alternatives may include storage (volume sensitive) and treatment (rate sensitive) options and balances. Multipurpose and integrated (dry-wet) facilities have been the most successful with process simplicity and operational control flexibilitiy prime considerations. Best Management Practices have decided benefits over structural alternatives--including lower cost, earlier results, and an improved and cleaner neighborhood environment--but lack quantified action-impact relationships. For combined sewer overflow abatement, increasing degrees of structural control is necessary. Successful program implementation is illustrated for several selected case histories.

USMTG
~27
~60

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c.
Disinfection, Drainage, *Water pollution, *Waste treatment, *Surface water runoff, *Runoff, *Wastewater, *Sewage, Contaminants, *Water quality, Cost analysis, *Cost effectiveness, *Storage tanks, *Storm sewers, *Overflows--sewers, *Combined sewers, Hydrology, Hydraulics, *Mathematical models, Remote control	Drainage systems, Water pollution control, Biological treatment, Pollution abatement, *Storm runoff, *Water pollution sources, Water pollution effects, Source control, *Urban hydrology, *Combined sewer overflows, Physical processes	

18. DISTRIBUTION STATEMENT	19 SECURITY CLASS *(This Report)*	21. NO OF PAGES
Release to Public	Unclassified	331
	20 SECURITY CLASS *(This page)* Unclassified	22 PRICE

EPA Form 2220-1 (9-73)

☆ U S. GOVERNMENT PRINTING OFFICE 1977-757-140/6582 Region No. 5-11

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/8-77-014	2	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE URBAN STORMWATER MANAGEMENT AND TECHNOLOGY: UPDATE AND USERS' GUIDE		5. REPORT DATE September 1977 (Issuing Date)
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18. DISTRIBUTION STATEMENT Release to Public	19. SECURITY CLASS (This Report) Unclassified	21. NO OF PAGES 331
	20. SECURITY CLASS (This page) Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

☆ U S GOVERNMENT PRINTING OFFICE 1977-757-140/6582 Region No. 5-11